DEVICE FOR MEASUREMENTS OF MULTIPLE SCATTERING AND OF TRACK CURVATURES IN NUCLEAR EMULSIONS

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Between the momentum p of a particle and the mean value of the absolute second differences, measured in constant cell lengths along a track, exists the well-known relation

$$p\beta \sim \frac{k \cdot z \cdot t^{3/2}}{|\bar{D}''|}$$

p = momentum
t = cell length
z = charge of the particle
k = scattering constant
$|\bar{D}''|$ = mean value of the absolute second differences

To determine the momentum of a particle from the track curvature the following relation is valid:

$$p \sim \frac{B \cdot t^2}{|\bar{D}''|}$$

p = momentum
B = strength of the magnetic field

The third differences are needed to eliminate C-shaped distortion in multiple scattering measurements. The magnitude of the Coulomb scattering of tracks curved by a magnetic field, can be determined by the third differences, too.

Operation of the device:

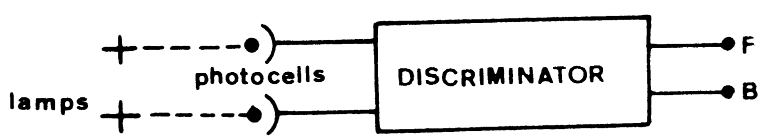

Fig. 1
Block diagram of the discriminator.

The measurements are carried out by means of an eyepiece-micrometer. On the screw of the micrometer a disc is fixed which is provided with slots. When the disc is turned the slots pass a double light barrier. A discriminator resolves the time difference of the pulses of the photo cells so far that pulses concerning the forward or backward movement, respectively, of the disc appear on the output F or B, respectively (Fig. 1).

The computor is constructed in such a way as to give a choice between two calculating modes, i.e. D', D", D"', or D', D", ΣD". The calculations are done in the binary system, whilst the calculated values are printed out in the decimal system.

After every value is put in from the microscope the following circle operates (Fig. 2):

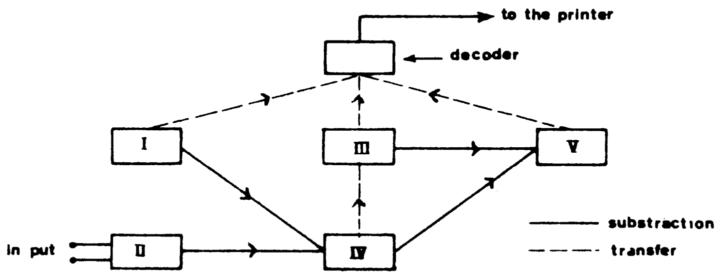

Fig. 2: Block diagram for the calculating circle

subtraction	II - I →	IV
transfer	I →	decoder
printing	I	
subtraction	IV - III →	V
transfer	III →	decoder and transfer II -- I
printing	III	
transfer	IV →	III and transfer V → decoder
printing	V	

The consideration of the sign is done in the following way. All stores at the entrances of which negative numbers might appear at the input or during the operating cyclus, i.e. the stores II,IV,V, were constructed as flip-flop stores counting backward and forward. The other stores can only count forward. All stores possess the same size; they are fitted for 14 flip-flops. In order to recognize the sign corresponding to each value printed out, the negative numbers appear in red colour. The calculating programme is built up by three elementary processes:

a) transfer from one store to another
b) subtraction
c) transfer from the binary into the decimal system

Transfer (Fig. 3)

A set of n pulses ($n = 2^{14}$, the capacity of the store) is put in at A. If the store contains the number z, a positive pulse, appearing at B after n-z pulses, will open the gate g so that z pulses appear at C.

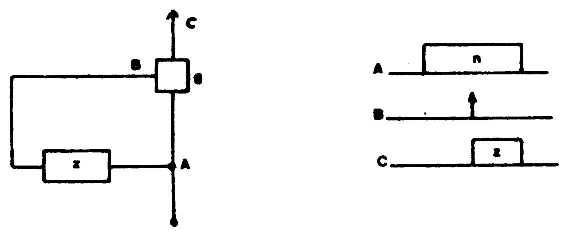

Fig. 3 Block diagramm for the transfer

Subtraction (Fig. 4)

Up to the points marked respectively as B or B', subtraction is fundamentally the same process as transfer. A pulse appearing respectively at B or B' will close the respective gates g_3 or g_4. A delay line of 0.5 μsec has been provided to ensure their being closed before pulses appear at their input. At the respectives exits C and C' the pulses z-z' appear according to z < z' or z > z'. Since in our case the difference between store II and store I is to be calculated, the negative numbers are assigned to the exit C, i.e. they arrive at the entrance of store IV which counts backward.

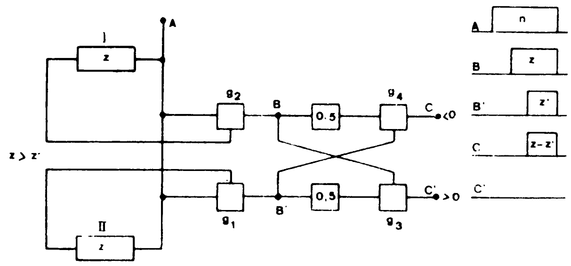

Fig. 4
Block diagram of the subtraction circuit.

Transfer from the binary into the decimal system (Fig.5.and 6.)
Wether there is a positive or a negative number contained in a store will be marked by the position of the final flip-flop. The gates g_2 and g_4 are opened and closed respectively by positive pulses. g_1 and g_3, however, are only opened if the corresponding exit of the final flip-flop is situated on a negative potential.

The steering of the calculating cyclus is done by a logical circuit which is built up by one-shuts and coincidence-gates steered by flip-flops.

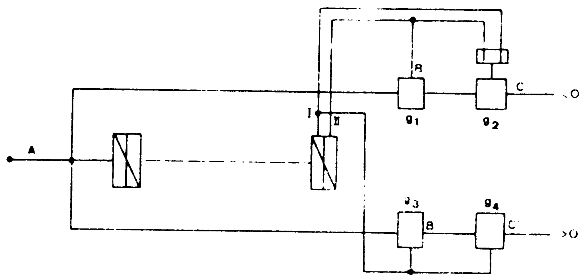

Fig.
Block diagram of the transfer circuit from the binary into the decimal system.

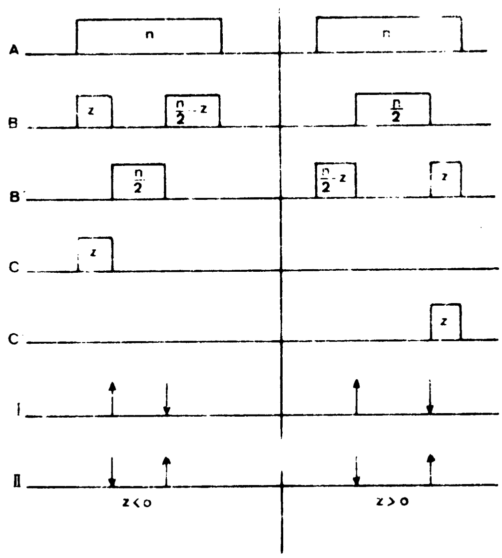

Fig.6 Pulse diagramm to Fig.5

Construction:

This device is connected to a microscope Koristka R4 . For the electronic construction special printed circuits have been prepared. The calculating machine is fully transistorized. The two calculating modes can be chosen by a switch on a keyboard. The caculated values are printed out by a printer 'Kienzle D1 SW' . The time for caculating and printing of a cyclus i.e. one D', one D" and one D'" is about 2.35 sec.

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